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Wobble: Shaping Unobtrusive Reminders for Prospective Memories in the Home Context

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ABSTRACT
Reminders are designed to support remembering actions or intentions to be performed later in time. Most technologies that have a reminding functionality do so by asking attention (e.g., by using auditory alerts or vibration patterns) from users at a certain point in time or location. Because of their obtrusive nature, the reminders of many (digital) prospective memory aids we use on a daily basis are hard to ignore, regardless of our ability and motivation to perform the reminded action or intention. In this paper, we present Wobble: an interactive cone-shaped artefact for reminding in the home environment. Wobble was designed to investigate peripheral reminders. Our results imply that wobble is best suitable for reminding intentions that do not require direct action but can be carried out over a period of time, which is a type of reminding currently not met by most electronic memory aids.

Author Keywords
Prospective Memory; Future Intention; Tangible Interaction; Persuasive Technology; Research Through Design; Peripheral Reminding; Multi-modal Interaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI):Miscellaneous;

INTRODUCTION
Prospective memory is used to remember future intentions [13]. An example of a future intention is: 'return a borrowed book'. To remember these future activities or intentions we make use of memory aids, which can be both analog and digital. Analog memory aids lose their novelty over time due to 'familiarity'. This makes them gradually lose their ability to stand out when they are supposed to remind the user of the cued intention. The majority of digital memory aids ask users' attention at a certain point in time or at a specific location. Reminders presented by these memory aids are designed to attract attention for example by using auditory alerts or vibrating patterns, which makes them hard to ignore- regardless of the user's ability to put it into practice. However, reminders for intentions, are more likely to be brought into practice when the user is able to perform the activity when reminded. Also, reminders for activities that cannot be executed when perceived by the user ('mismatched' reminders) can cause frustration or annoyance [4]. The success of an executed (future) intention can be defined as a product of a user's *ability* and *motivation* at the time of perceiving the reminder (or: '*trigger*', 'cue') [4]. The frustration and annoyance caused by mismatched reminders is an issue which existing digital memory aids do not address. We believe reminders should not be designed to force the user to focus on each reminder (e.g., by simply designing very obtrusive reminders). Instead we believe that reminders that are easier to ignore than traditional reminders can be presented more often, and may be picked up by users when they are more open to be reminded. To evaluate these sorts of reminders we build on the concept of 'peripheral interaction' [2]. We aim to apply peripheral interaction to the design of a reminding application and explore how unobtrusive reminders for cued intentions are experienced in the home context. In addition we are interested in how a tangible approach to creating memory cues influences the ability to recall cued intentions. We explored this concept using research-through-design [5][20], in which we iteratively created an interactive prototype called 'Wobble'. We evaluated Wobble in a user study and present generalized insights for the design of unobtrusive memory aids.

THEORETICAL BACKGROUND AND RELATED WORK
This paper explores a tangible artifact to support reminding in the periphery of attention. In this section we discuss theories of prospective memory, in which our design is grounded, and we discuss related work in the area of peripheral interaction.

Figure 1. Wobble prototype.

Prospective Memory Cues

People often use memory cues to remember intentions and actions that need to be performed at a point of time in the future. To discern remembering future intentions (prospective memory) from remembering past experience (retrospective memory), we call these cues 'prospective memory cues'. Future intentions are remembered when prospective memory cues [3] are triggered. They can be created intentionally by people (using memory aids) but can also spontaneously come to mind [13]. Depending on the specifics of the intention the memory cues can be event-based, time-based or location-based. Various memory aids have been designed to support the prospective memory for a diverse range of situations, locations and intentions. For example, the apps Wunderlist [19] and Any.Do [1] have been designed for the purpose of reminding by enabling users to create lists. These applications overlap with the old-fashioned pen and paper list making, but differ in their ability to actively remind the user at a predefined moment in time. Differently, Google Now [7], Cues [14] and Place-it's [17] are applications that actively remind users of tasks at relevant locations, using GPS technology.

Calm Technology and ambient displays

While the above-mentioned reminding applications are designed to attract the user's attention (using alerting notifications), ambient displays [11] or peripheral displays [12] are designed to inform people without alarming or intruding. Such ambient displays find their origin in the vision of Calm Technology, described as "that which informs but doesn't demand our focus or attention" [18], and characterized by information shifting back and forth between the center and periphery of attention. The prototype ReMind [10] unobtrusively prompts users to perform an action by a rotating wall-mounted disk, on which tangible tokens are placed to represent specific intentions. Move-it Sticky Notes [15] enhances physical sticky notes with technology which allows them to move in order to subtly draw attention. The design presented in this paper adds to these existing works, by exploring a combination of sound and movement to create subtle reminders, and by relying on a portable and open-ended design which is hypothesized to be particularly suitable in the home-context, where the timing of tasks and activities are generally more flexible compared to the office context.

PERIPHERAL REMINDING ARTEFACT: WOBBLE

Wobble (depicted in Figure 1) is an open-ended memory aid that produces reminders designed to be perceived in the periphery of attention. It is a research instrument created to explore peripheral interaction in the domain of prospective memory (retrieval). Wobble both allows for creating memory cues and provides the reminder.

Wobble is a cone-shaped tangible artefact that produces reminders by physically rotating. When Wobble rotates it generates a subtle sound as a consequence of the friction with the surface it is positioned on. These reminders are hypothesized to be more subtle than traditional reminders since wobble produces a softer, more calm sound. Additionally, subtlety may be realized by the location at which the sound is generated, which is not necessarily produced near the user (as memory aids on mobile phones are). Its tangible design allows Wobble to be placed in different locations, depending on the user's wishes. Wobble provides multiple unobtrusive reminders over a longer period of time, in contrast to just one obtrusive reminder at one specific moment. Because of their subtlety, Wobble's reminders are likely easier to ignore or to 'miss' than reminders with a more alarming character.

Reminders that are presented both visually and auditory are more likely to be perceived when one modality is overshadowed by a more dominant information source. The multi-modality of Wobble's reminder has another advantage: when a user is able to link the perceived visual and auditory information to the same event, the perception of the reminder is strengthened [6].

Figure 2. Close-up of Wobble's tip and user interface.

Wobble allows for tangible creation of prospective memory cues and its reminder's relevance can be set using location (where Wobble becomes active) and time (when Wobble is set to become active). This portability allows the user to increase the likelihood that reminders are noticed at relevant locations. The desired timing is determined using Wobble's tangible user interface [9]. Wobble's tip includes an on/off-button and two scroll wheels, which can be rotated to set Wobble's behavior. Scroll wheel 1 allows the user to determine in how many hours the reminder should become active (varying from 0 to 24). Scroll wheel 2 can be used to determine the frequency with which Wobble becomes active in the period until the final reminder. This value varies between 1 time per 2 hours to 4 times per hour.

A prototype was made for evaluating Wobble's reminders in a user study. The (15 cm long) Wobble prototype exists of two robust parts that encapsulate the electronics required for functioning. These parts are connected by a geared axis. Weight is strategically added to ensure Wobble rotates around its (blue) tip. A LightBlue Bean microcontroller [16] enables Wobble to function independently. The rotation of Wobble is realized using a small, silent stepper motor. The home-context is less often explored in relation to prospective memory cue retrieval than other contexts. We believe Wobble's reminders are suitable for many actions or intentions people want to be reminded of in the home-context. Firstly because the multi-modal reminders allow users to be reminded while other sources of information are more dominant. Also Wobble can be relocated, allowing users to set reminders in various parts of the house.

USER STUDY

To gain insights in the use of Wobble as an external memory aid and the related experience in the home context, a user study was to conducted. Since the home is a dynamic context, that differs from person to person both in physical setup and in present routines, we believe the experience of Wobble can only be evaluated when deployed in the real context of use. We therefore decided to conduct an 8-day field study in the participants' own home environment.

In a one-on-one meeting, the study was explained to the participants. Wobble and a diary booklet were handed out and demonstrated. Wobble's functionality was explained as an open-ended memory aid, designed to support remembering future intentions. After demonstrating the Wobble prototype was handed over to the participant for a period of 8 days. During this period the participant was free to interact with Wobble in whatever way they thought would suit the purpose of a memory aid.

3 participants were selected to evaluate Wobble. Participant A was a 33-year-old woman, who lived with her 5 and 6-year-old sons. Participant B was a 32-year-old man, who lived together with his girlfriend and owned a cat. The third participant (Participant C) was a 25-year-old man, who lived together with his fiancée. All three participants had a full-time job for which they left the house during weekdays. We handed out a diary booklet that explained Wobble's functionality and contained a section in which the participant was asked how Wobble was set and how its reminders were perceived. Participants were asked to answer these questions one day after they had used Wobble, to minimise the influence the act of filling in the questions had on the study. If the participants did not use Wobble during one day of the study, they were asked to leave the fields related to that day empty. The user evaluation concluded with a semi-structured interview to gain in depth insights on the experience of using Wobble. The interview contained questions such as "How did you use Wobble and on what time interval did you set it?". Additionally, we asked why Wobble was used the way it was used, and how Wobble's reminder was experienced in comparison to those of other memory aids. The diary booklets were used as base for the semi-structured interviews, to help participants to recall the intentions cued with Wobble.

Figure 3. Wobble during the user study.

FINDINGS

The data gained through the interviews was analysed using 'affinity diagramming' [9]. The answers to the interview questions were transcribed and clustered to find common themes within the data. The following clusters were found:

Usage of Wobble and examples of cued future intentions

In the 8-day period Participant A used Wobble 5 times, Participant B and C used Wobble 7 times. None of the participants used Wobble more than once per day. Content-wise the future intentions cued with Wobble in this study were low in complexity. The participants used Wobble to remind themselves to execute relatively simple activities such as 'administer anti-biotics to the cat'. Participants did not use Wobble to remind themselves of intentions that involve multiple consecutive activities (e.g., making a holiday planning). All participants stated they used different memory aids to be reminded of these more complex intentions during the study. Participants B and C stated that in some cases Wobble helped to remind them to execute activities which they "probably would have forgotten otherwise". Participant B stated Wobble worked especially well for intentions related to activities out of his daily routine, that were not strictly linked to a specific point in time and did not rely on a narrow time window to be executed. These time-based intentions were allocated a few hours in which they needed to be executed.

Experience of Wobble's reminders

Participant B and C indicated to experience Wobble as a valuable addition to the existing set of memory aids and indicated to appreciate the subtlety of Wobble's reminders. Participant B for example stated that the subtle reminders "allow Wobble to get the user's attention without being pushy". However, in some cases, participants also stated that the reminders "could be more dominant" to make them easier to notice.Participant B and C explicitly stated they appreciated that Wobble's reminders would become active not only once but multiple times. According to them, this allowed for "snoozing" when not able or motivated to put an intention into practice. In that case Wobble's reminders could be ignored, without being afraid to forget to put the intention into practice afterwards. Participant B for example indicated that he 'snoozed' (ignored) Wobble while playing a video game, counting on it to become active again later.

Prompt to action

For Participant A Wobble's reminders were insufficient to recall the cued intentions. Participants B and C indicated to have no problems recalling their cued intentions, but that they would see value in increasing the amount of information that can be stored in Wobble to "make Wobble suitable for cueing more complicated intentions."

Location of use

We learned that Wobble was mainly used in the living room or kitchen. It was usually placed on large surfaces such as the kitchen table (see Figure 3), cupboard or the floor, where it could freely rotate without risking a situation in which people would step on it. Participants B and C placed Wobble on the terrace floor when sitting outside multiple times. Participant A stated that Wobble did not work for her because she is "always on the run". She indicated that she usually writes down the things she needs to do on post-it notes, which are stuck to the kitchen door.

DISCUSSION

The goal of the study was to evaluate the use and experience of Wobble as an open-ended prospective memory aid. In this section we discuss the implications of the study's findings. Participants indicated that they had failed to notice some reminders they were 'supposed' to perceive; they were near Wobble when it was active, but did not notice the reminder. This for example happened when the participant was engaged in other activities.

We also found cases in which Wobble's reminders *were* perceived while a participant was for example playing a video game. The fact that in both cases the reminders did not result in a negative experience or frustration might be an indicator of Wobble's ability to provide reminders subtle enough to be ignored when irrelevant or when the participant is occupied.

We found that the intentions for which the participants used Wobble's were often not linked to a specific point in time at which the intention needed to be executed.

We find it interesting to see how the irrelevant reminders resulted in participants ignoring reminders, knowing the reminder would return later in time. The idea of users choosing to (for the moment) ignore a reminder created an interaction that current reminding applications do not facilitate. The moment a participant 'snoozes' Wobble he can estimate how his ability or motivation to perform the to-be-executed activity relate to each other in a future scenario. Wobble currently does not allow for indicating the purpose of a reminder through writing. For Participant A contextual information alone was insufficient to recall cued intentions. For Participants B and C this information was sufficient, but still only relatively uncomplicated intentions were cued. Therefore we think Wobble might benefit from a link to systems (e.g., existing mobile phone applications or online calendars) to allow users to digitally insert more information on the cued intention. This additional information could make it easier to recall the cued intention while maintaining the tangible user interface. This could also help to present the reminders for these systems less alarming than their current reminders. In our user study Wobble was mainly used in the living room or kitchen, placed on large surfaces. This might have to do with Wobble's dimensions, which make it unsuitable to place on smaller surfaces such as the windowsill. However, the fact that the participants allocated Wobble to the kitchen and living room (and sometimes outside to the terrace) indicate that Wobble's portability is used as a means to determine (anticipated) relevance.

Since Wobble's tangibility seemed successful, even with its current dimensions, a future direction in this research should use a smaller prototype, to further enhance this ability. During the user study we found that the 'interim-reminders' did remind the user of the to-be executed intention, but often did not prompt the participants to action. Such 'snoozing' might sound as procrastination rather than a prompt to action. However, being able to ignore the reminder allowed participants to find a future moment in which they expects to be both motivated and able to perform an activity too. Participants B and C considered Wobble a valuable addition to the existing set of memory aids, since Wobble reminded them of their future intentions without being pushy. Therefore Wobble does not replace the post-it notes or mobile phone applications, but could be used as an addition to these existing memory aids by providing reminders that do not ask attention obtrusively. This means Wobble can also be beneficial in cases where participants are unable to perceive the reminder, or if they are interrupted while executing the activity.

CONCLUSION

The aim of the work presented in this paper was to explore tangible interaction to support people's prospective memory in the periphery of attention. Following a research-through-design process we designed a memory aid called 'Wobble', an artefact that offers peripheral reminding, and evaluated it with three participants in the home context. In particular, we explored how timing and location supported reminding. We hypothesized that peripheral reminders, perceived when being open to perform the intention the reminder was set for, and easily ignored when engaged in other activities, improve the likelihood of an intention being carried out and decrease the times people get disturbed (and frustrated by) reminders.

The results of our study indicate that the series of multiple subtle reminders presented by Wobble seemed to support participants to execute activities which they stated they 'would probably have forgotten otherwise'. Wobble was used mainly to cue intentions related to relatively uncomplicated intentions that did not rely on a specific time window to be executed. This work contributes to the field of prospective memory aids with reminding applications by exploring how peripheral interaction can be applied in the domain of reminding applications in the home context.

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